Monitoring Ice Jams Using NASA Earth Observation Systems (EOS) in the Yukon River Basin

by

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INTRO

Three pictures of the 2009 Eagle ice jam are shown, provided by the NWS.

EXT. SCENE. DAY – Building 647 on Langley Air Force Base. 07-30-2012

It's a windy afternoon, outside of the DEVELOP office in Hampton, VA at Langley Research Center. The six participants, JACOB, CASEY, NEIL, KRISTEN, CHRISTINA, and HOLLY of NASA's DEVELOP Program stand outside by the Chesapeake Bay. All are dressed in business casual clothing in a line, one behind the other.

SHOT – Full, Outside

JACOB

Hi! I'm Jacob Banitt

CASEY

I'm Casey Cavanagh

NEIL

I'm Neil Turnock

KRISTEN

I'm Kristen Pyne

CHRISTINA

I'm Christina Furst

HOLLY

I'm Holly Widen and we are the Alaska Disasters Team!

SHOT – Picture of 36 states affected by ice jams in US.

KRISTEN

Ice jams commonly go unheard of because they usually occur in remote areas. Annually, they cause $125 million in damages in 36 US states.

SHOT – Google Earth zoom on Eagle, Alaska

CHRISTINA

Our study area is the Yukon River Basin, however, our methodology can be applied to any other area at risk of ice jam flooding. One of the case studies selected was Eagle, Alaska which suffered from an ice jam disaster in May of 2009 leaving a quarter of their population homeless.

SHOT – NWS LOGO

NEIL

We are partnering with the National Weather Service in Anchorage and Fairbanks, Alaska for this project.

SHOT – Google Earth fly over of Yukon River at Eagle

JACOB

The NWS currently monitors ice jams using the River Watch Program and river observers. The River Watch program requires three planes flying over different sections of the 1000 mile long river to provide flood warnings to the people downstream of the breakup front. Contrary to that, river observers are people on the ground but due to the sparse population the information is limited.

EXT. SCENE. DAY. By the Chesapeake Bay on Langley Air Force Base. 07-27-2012

HOLLY

Our mission is to provide our partner with a more cost effective methodology that they can use remotely using NASA's earth observing systems to monitor and mitigate ice jams on the Yukon River Basin

JACOB

The three main variables that we decided to focus on are springtime temperatures, ice thickness and snow water equivalent.

SHOT – Graph of the temperatures from the winter of 2008 to 2009 compared to the averages and extremes for Eagle, Alaska.

JACOB

From this graph its apparent that a heat wave occurring at the end of April and beginning of May coinciding with the time of breakup is a pivotal event in determining whether an ice jam will occur because the ice is not allowed to thaw properly when shocked by such extreme temperatures.

SHOT – Graph of 2009 April ice thickness for Eagle, Alaska.

JACOB

Related to springtime temperatures, ice thickness also plays a role in determining the severity of ice jams. This graph shows that the year of 2009 had ice thickness values well above average.

SHOT – HIVE Video

HOLLY

For the 2009 Eagle Alaska ice jam, the jam occurred 10 miles downstream from Eagle. River observers recorded the ice thickness to be 7-8 feet thick along the river and the flood reached 51.3 feet in the town. Four homes were torn from their foundation and two were carried downstream. Also, the only grocery store and medical clinic were destroyed.

SHOT – Surface Temperature Video for Eagle, Alaska in 2009

NEIL

Our team created a time series that illustrates the surface temperature of the Yukon River Basin from April 28 to May 4th. This is a good visualization of the springtime temperature graph because the heat wave is evident.

EXT. SCENE. DAY. By the Chesapeake Bay on Langley Air Force Base. 07-27-2012.

KRISTEN

We used Landsat 7 for a surface temperature analysis.

SHOT – Landsat 7 images

KRISTEN

We calculated the brightness temperature of band six and compared to the near IR band four to illustrate where ice was located along the river. Areas on the river that are yellow show where breakup has occurred and appear a darker grey in the IR band.

EXT. SCENE. DAY. By the Chesapeake Bay on Langley Air Force Base. 07-27-2012.

NEIL

A flood extend map was created using ASTER and IKONOS 2 images.

SHOT – Flood Extent Map

NEIL

The outer area highlighted in green was mapped using the IKONOS-2 image showing the flood extent 5 days after the Eagle ice jam and the inner area highlighted in red was mapped using the ASTER image showing the flood extent 14 days after the Eagle ice jam.

SHOT – Combining three MODIS images together

CASEY

In order to effectively use MODIS for monitoring potential ice jam locations, we needed to first find a way to remove as much cloud cover as possible. We wrote a program in Python that compared the target day with the previous two days. Wherever clouds were present, pixels from the previous two days were gathered.

SHOT – MODIS Fractional Snow Cover.

CASEY

With many of the clouds removed, we then were able to use the Fractional Snow Cover product for predicting potential ice jam locations. For example, the 2012 ice jam at Manley Hot Springs

was tracked. Regions that are green indicate that all snow has completely melted and grey areas indicate varying percentages of snow cover. The snow/bare ground boundary expands toward Manley Hot Springs. On April 28th, the ice jam occurred. We found that the ice jams are most prone to occur a day or two after all snow cover has melted around the surrounding area.

EXT. SCENE. DAY. Kristen at her desk in building 647 on Langley Air Force Base

KRISTEN

We used MODIS to track the difference between ice and water on the Yukon River from May 3 to May 28, 2006.

SHOT – Time series of MODIS

KRISTEN

Light blue represents ice on the river and dark blue represents water. On May 11 around Circle an even mixture of ice and water is visible indicating a high risk for an ice jam. A similar event can be seen at Marshal on May 24th. However, on May 28th the ice had moved downstream meaning that the risk of an ice jam had passed.

EXT. SCENE. DAY. Casey at his desk in building 647 on Langley Air Force Base

CASEY

Our Python program was also used to track daily change in snow cover.

SHOT - Daily change of snow cover, time series using MODIS

CASEY

Green areas are previously melted. By comparing the change of daily temperature you can see how snow cover is affected by heating. Again the melt boundary moves towards Manley Hot Springs in the days preceding the ice jam.

EXT. SCENE. DAY. Christina at her desk in building 647 on Langley Air Force Base.

CHRISTINA

To conclude our project, we have found that MODIS imagery can be applied as a forecasting tool to give ice jam warnings.